

POS  
6088

Peabody Museum  
of Natural History  
New Haven, Ct. 06520

**A New Aquatic Eosuchian  
from the Newark Supergroup  
(Late Triassic-Early Jurassic)  
of North Carolina and Virginia**

Paul Eric Olsen

MUS. COMP. ZOOLOG.  
LIBRARY

FFA 13 1024

Received 13 October 1977

**Abstract**

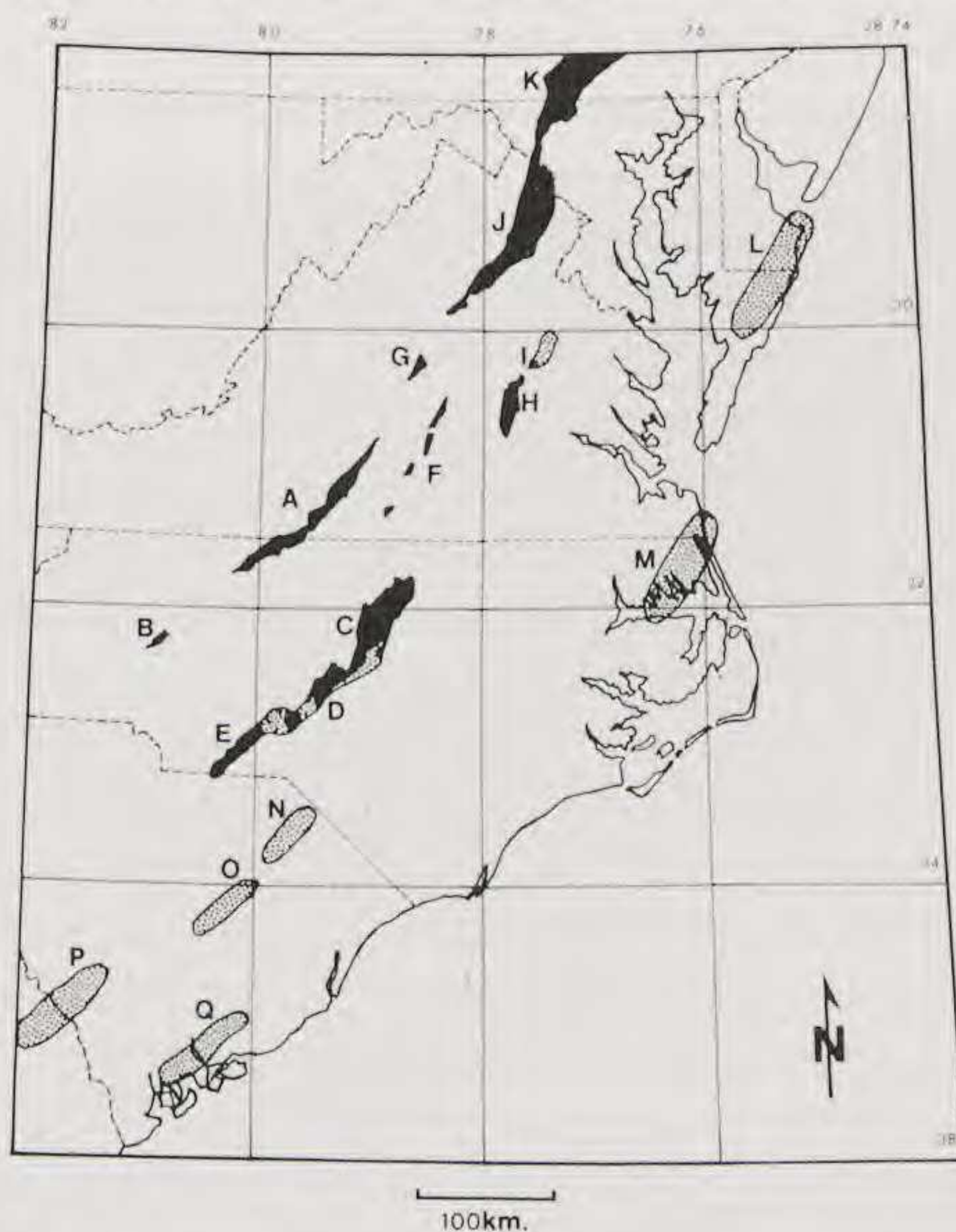
*Tanytrachelos ahynis* (n.gen., n. sp.) is a lepidosaur from the Late Triassic Dan River Group (Newark Supergroup) of North Carolina and Virginia. The new reptile has gracile proportions similar to *Tanystropheus* (Middle Triassic) and is referred to the family Tanystropheidae of the suborder Prolacertiformes. Unlike *Tanystropheus*, *Tanytrachelos* has relatively short cervical vertebrae bearing splintlike ribs anteriorly and plowshare-shaped ribs posteriorly. The species is much smaller than *Tanystropheus* and has long straight ribs fused to the most distal dorsal vertebrae and proximal caudal vertebrae. The associated fish and nonmarine invertebrate fauna and flora suggest that the age of the *Tanytrachelos*-bearing horizon is Middle Keuper (Carnian of the Late Triassic).

sented by the Newark (at least Late Triassic through Early Jurassic, Olsen and Galton, 1977), knowledge of this interval has been very sketchy, primarily because it was thought to be fossil poor.

This negative concept had to change in 1974, when a locality in the upper member of the Cow Branch Formation of the Dan River Group [Newark Supergroup of North Carolina and Virginia (Thayer, 1970)] was discovered (Fig. 1). This site has yielded many skeletons

**Introduction**

The Newark Supergroup (Olsen, 1978; Van Houten, 1977) consists of thick continental sequences preserved in discrete basins exposed in the Piedmont province of eastern North America from Nova Scotia to South Carolina. Despite the great geographic area involved and the considerable time repre-



**Fig. 1** Map of southeastern United States showing extent of Newark Supergroup Rocks. A, Dan River Group; B, Davie County Basin; C, D, E, Durham, Sanford, and Wadesboro Basins of Chatham Group; F, Farmville Basin and minor basins to the south; G, Scottsville Basin; H, Richmond Basin; I, Taylorsville Group; J, Culpeper Basin; K, Gettysburg Basin; L, M, N, O, P, Q, Newark Supergroup rocks inferred to exist below the Coastal Plain sediments.

© Copyright 1979 by the Peabody Museum of Natural History, Yale University. All rights reserved. No part of this publication, except brief quotations for scholarly purposes, may be reproduced without the written permission of the Director, Peabody Museum of Natural History.

of small reptiles, reptile footprints, five genera of fish, abundant insects, other arthropods, and a rich megafossil flora (Olsen, et al., 1978) constituting a reasonable representation of a large Late Triassic lake. In this lake lived abundant tanystropheid lepidosaurs and their remains form the basis for this report.

Prior to the discovery of the Cow Branch reptile, the family Tanystropheidae was definitely known only from the marine Middle Triassic *Tanystropheus* (Peyer, 1931). This form is characterized by an extremely long neck and skeleton with a number of lizardlike features: the resemblance has suggested to some (Wild, 1973) that *Tanystropheus* was, in fact, a true lizard. Recent advances in our understanding of lizard phylogeny (Gow, 1975; Carroll, 1977) suggest that *Tanystropheus* is closely allied to the lizardlike family Prolacertidae, and that true lizards have had a completely independent history. It now seems that the prolacertilians (including *Tanystropheus*) underwent a radiation of their own culminating in the Middle Triassic, prior to their replacement by aquatic true lizards, plesiosaurs, and archosaurs.

A comparison of the diminutive Cow Branch tanystropheid, certainly lacustrine, with the giant (ca. 6 m) *Tanystropheus*, found in marine deposits, points up the differing sorts of trophic strategies present in closely related species living in different environments. In fact, many of the gross morphological differences between the new reptile and *Tanystropheus* are such that one could be "derived" from the other by relatively simple geometric transformations; hence, a number of interesting evolutionary interpretations come to mind (Gould, 1977). These interpretations, as well as the functional anatomy and ecological relationships of the new reptile will be dealt with in a separate work. Now, however, it is appropriate to present a brief diagnosis and description of this tanystropheid to facilitate further work and reference.

### Material and Methods

The material for this work consists of more than 100 skeletons in various states of

completeness from a single locality (see below) in the upper member of the Cow Branch Formation.

All of the skeletons are preserved as black or silvery compressions on black or gray laminated dolomitic siltstone; their preparation is hindered by a thin covering of this siltstone. It can be cleaned off by several weeks of soaking in dilute acetic acid (ca. 15%) followed by careful removal of the matrix by the "air-brasive" method. Two specimens have been prepared in this manner; three required no preparation. The majority of the findings presented in this paper are principally based on these five specimens.

### A Note on the Locality

The owners of the *Tanytrachelos* locality have been extremely cooperative but do not want the position of the site to become common knowledge; therefore, a code will be used for the locality data, the key to which is recorded in the archives of the Yale Peabody Museum (Olsen, 1978a). The first reptile specimens were found in displaced boulders that were later traced to their origin. Both the area of displaced boulders and the extensive exposures that produced them are termed CB1. A number after CB1 indicates the exact stratigraphic position of the fossil or fossiliferous unit, and a letter after that gives the geographic location. The locality designation for the area of displaced boulders is CB1-A (no stratigraphic position) and those of four collecting sites along a single horizon are CB1-2-B, CB1-2-C, CB1-2-D, and CB1-2-E (see Fig. 9). The quarry from which most of the material was recovered is at CB1-2-D. Several specimens have also been recovered from units CB1-3 and CB1-16 from the same large exposure as CB1-2-B through CB1-2-E.

### Systematic Paleontology

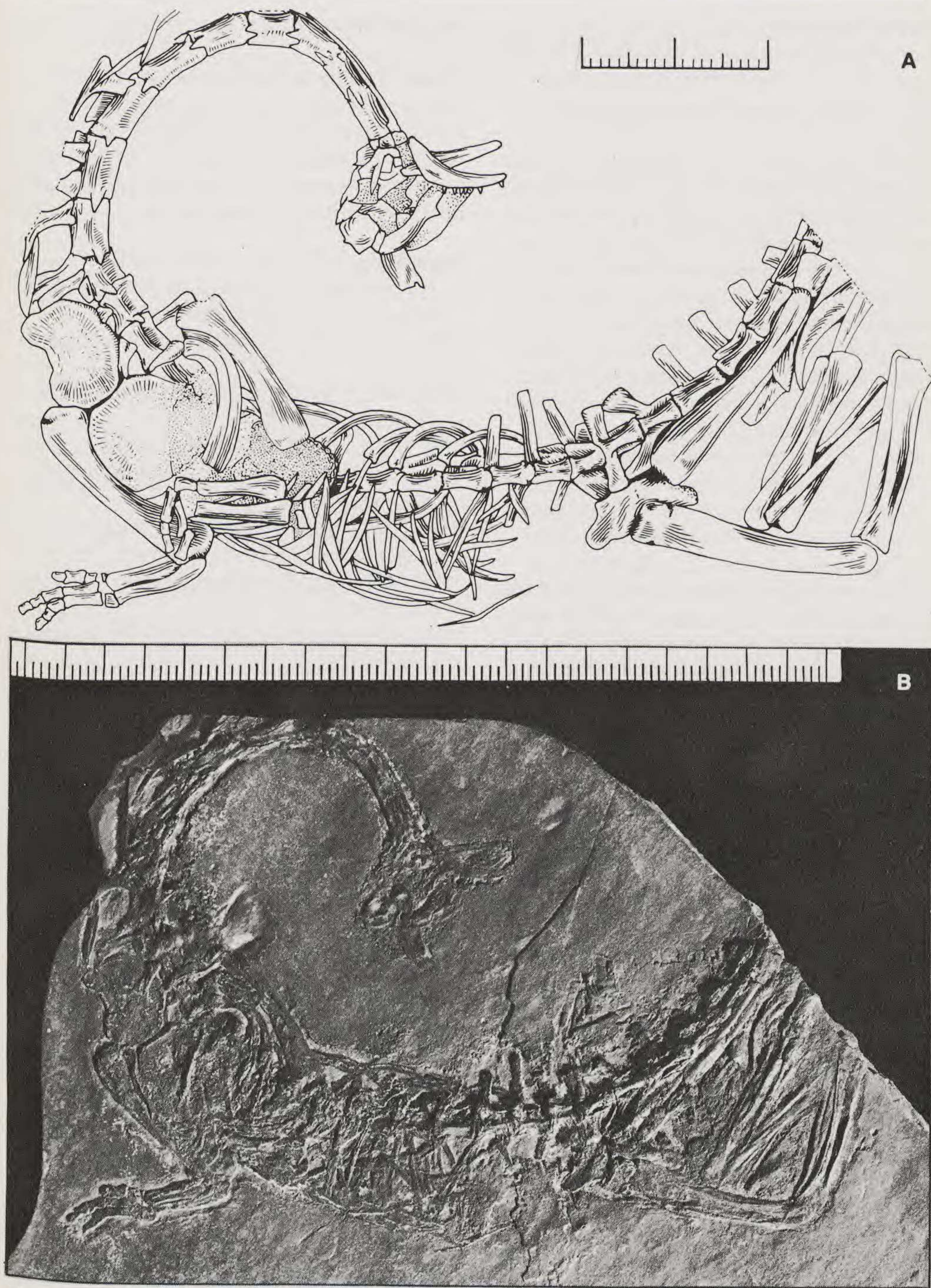
Class **Reptilia**

Subclass **Lepidosauria**

Order **Eosuchia**

Suborder **Prolacertiformes**

Family **Tanystropheidae** Gervais, 1858



**Fig. 2**  
The type specimen of *Tanytrachelos ahynis* (YPM 7496) A, line drawing, scale 2 cm; B, photograph, scale in mm.

**Family Definition:** Small (18 cm) to very large (6 m) lepidosaurs, with an elongate body and neck. Skull diapsid with incomplete jugal arch; orbits large and lower jaw slender. 12 cervical, 13 dorsal, 2 sacral, and up to 46 caudal vertebrae, all amphicoelous (in *Tanystropheus*) or procoelous (in *Tanytrachelos*). Cervical and anterior dorsal ribs dicephalous, but capitulum reduced on posterior dorsal ribs. Last two or three dorsal vertebrae with straight ribs fused to the centra. Interclavicle quadrangular; clavicles blade-like; coracoids oval; scapular sublunate. Forelimbs considerably shorter than hind; manus with short metacarpals and a phalangeal formula of 2, 3, 4, 4, 3. Pelvic girdle of general lepidosaur nature with a large thyroid fenestra. Hind limbs long; pes with a large calcaneum and astragalus; metatarsal V hooked and short; proximal phalanx of V elongate; pes phalangeal formula 2, 3, 4, 5, 4. Gastralia numerous with each element composed of four pieces forming a "V" in shape. Paired, triangular heterotopic bones present alongside the fourth through sixth caudal vertebrae in some specimens.

As defined here the family Tanystropheidae includes *Tanystropheus*, *Tanytrachelos* (n.gen.), possibly *Cosesaurus* (Ellenberger and de Villalta, 1974) and an undescribed reptile from India (Cruickshank, 1972).

**Distribution:** Anisian-Landinian (Middle Triassic), Central Europe; ?Anisian, eastern North America; Middle Triassic, Middle East and India; Late Carnian (Late Triassic), eastern North America.

***Tanytrachelos***, new genus

**Type Species:** *Tanytrachelos ahynis*, new and only known species.

**Distribution:** Late Triassic (Late Carnian) of south-central Virginia and central North Carolina.

**Diagnosis:** Same as for species; see below.

**Etymology:** *Tany* (Greek), long; *trachelos* (Greek), neck. Name suggested by John H. Ostrom.

***Tanytrachelos ahynis***, new species

**Type:** YPM (Yale Peabody Museum) 7496, a nearly complete Type A individual, missing both peds and posterior portion of tail. Locality CB1-2-C. Note that "Type A" or "Type B" refer to the presence of a presumably sexually dimorphic character (see Fig. 2).

**Hypodigm:** YPM 7491, large Type B, missing neck and skull. Anterior portion of trunk disarticulated. Locality CB1-A.

YPM 7702, complete small Type A. Locality CB1-A.

YPM 7485, Type A, missing tail and most of skull. Locality CB1-A.

YPM 7484, Type B, with good trunk, neck, and proximal portion of tail. Locality CB1-2-B, weathered zone.

YPM 7644, Type B, missing tail, legs, and skull. Locality CB1-2-B, weathered zone.

YPM 7490, Type B, missing portion of trunk. Locality CB1-2-C.

YPM 7492, partially disarticulated specimen. Locality CB1-2-C.

YPM 7493, Type A, missing part of neck. Locality CB1-2-C.

YPM 7494, large Type A, missing part of neck and skull. Locality CB1-2-C.

YPM 7486, Type B, missing distal parts of hind limbs and tail. Locality CB1-2-D.

YPM 7487, Type B, missing anterior portion of skeleton. Locality CB1-2-D.

YPM 7488, excellent neck. Locality CB1-2-D.

YPM 7489, Type A, missing one pes and distal portion of tail. Locality CB1-2-D.

YPM 7495, Type A, missing anterior portion of skeleton. Locality CB1-2-D.

YPM 7497, Type B, missing skull and one leg. Locality CB1-2-D.

YPM 7498, Type B, fragmentary skeleton. Locality CB1-2-D.

YPM 7499, Type A, fragmentary skeleton. Locality CB1-2-D.

YPM 7540, pes and distal part of tibia and fibula. Locality CB1-2-D.

YPM 7541, anterior three-quarters of skeleton preserving outline of soft tissue. Missing tail and both feet. Locality CB1-2-D.

YPM 7542, fragmentary skeleton with good pes. Locality CB1-2-D.

Table 1. Some selected measurements of *Tanytrachelos ahynis*. Sex refers to whether it is a Type A or Type B individual. (See "Discussion" in text.) Measurements are averages of left and right limb bones and several dorsal vertebrae.

YPM Number	7496	7485	7487	7491	7493	7621	7622
"Sex"	A	A	B	B	A	A	A
Length (mm)							
Dorsal vertebrae	5.0	4.8	4.0	6.7	7.7	6.2	4.5
Femur	27.0	23.6	17.3	35.2	27.0	30.3	27.8
Tibia	20.5	15.9	11.8	18.3	22.5	21.4	15.8
Metatarsal III	—	11.0	8.2	18.0	15.5	17.5	13.4
Humerus	22.2	—	—	29.0	24.6	23.0	24.7
Ulna	10.5	—	—	14.0	10.0	12.0	10.3

YPM 7612, fragment of trunk and pectoral girdle. Locality CB1-2-D.

YPM 7615, Type B, complete skeleton. Locality CB1-2-D.

YPM 7617, parts of several individuals. Locality CB1-2-D.

YPM 7618, Type A, missing pectoral girdle, forelimbs, neck, skull, and tip of tail.

YPM 7619, Type B, missing head and end of tail. Locality CB1-2-D.

YPM 7620, articulated humerus, radius, and ulna. Locality CB1-2-D.

YPM 7621, Type A, excellent disarticulated skeleton, missing tail tip and skull. Locality CB1-2-D.

YPM 7622, Type A, lacking most of skull, one foot, and end of tail. Locality CB1-2-D.

YPM 7623, Type B, missing tail tip. Locality CB1-2-D.

YPM 7626, Type A, missing skull and tail. Locality CB1-2-D.

YPM 7628, Type A, missing skull and tail. Locality CB1-2-D.

YPM 7629, Type B, complete skeleton. Locality CB1-2-D.

YPM 7630, Type B, complete skeleton. Locality CB1-2-D.

YPM 7632, impression of anterior portion of skeleton. Locality CB1-2-D.

YPM 7633, Type A, pelvis and legs. Locality CB1-2-D.

YPM 7649, Type A, missing neck, head, and tail end. Locality CB1-2-D.

YPM 7482, very good skull and anterior portion of body. Locality CB1-2-E, weathered zone rubble.

YPM 7501, 7502, poor fragments. Locality CB1-A.

YPM 7614, 7625, 7631, 7611, 7634, 7635, 7637, 7638, 7639, 7640, 7641, 7642, 7643, 7645, 7647, 7648, 7650, 7651, 7652, 7653, 7654, fragments. Locality CB1-2-D.

YPM 7483, fragment. Locality CB1-2-E, weathered zone rubble.

YPM 8172, fragmentary skeleton. Locality CB1-3.

YPM 8173, good partial skeleton missing distal part of tail. Locality CB1-3.

YPM 8075, fragment. Locality CB1-16.

**Horizon:** Upper member of the Cow Branch Formation, Dan River Group, Newark Supergroup. Most specimens from laminite (Division 2) of cycle number CB1-2, at localities CB1-2-B through CB1-2-E, or from rubble (locality CB1-A) presumably from cycle number CB1-3. Several specimens have been removed from in situ in CB1-3. Position

of the units is about 540 m above the base of the upper member of the Cow Branch Formation. One possible specimen is from cycle number 16 (CB1-16, about 415 m above base of the upper member of the Cow Branch Formation).

**Etymology:** a (Greek), with *hynis* (Greek), plow, in reference to the plowshare-shaped cervical ribs.

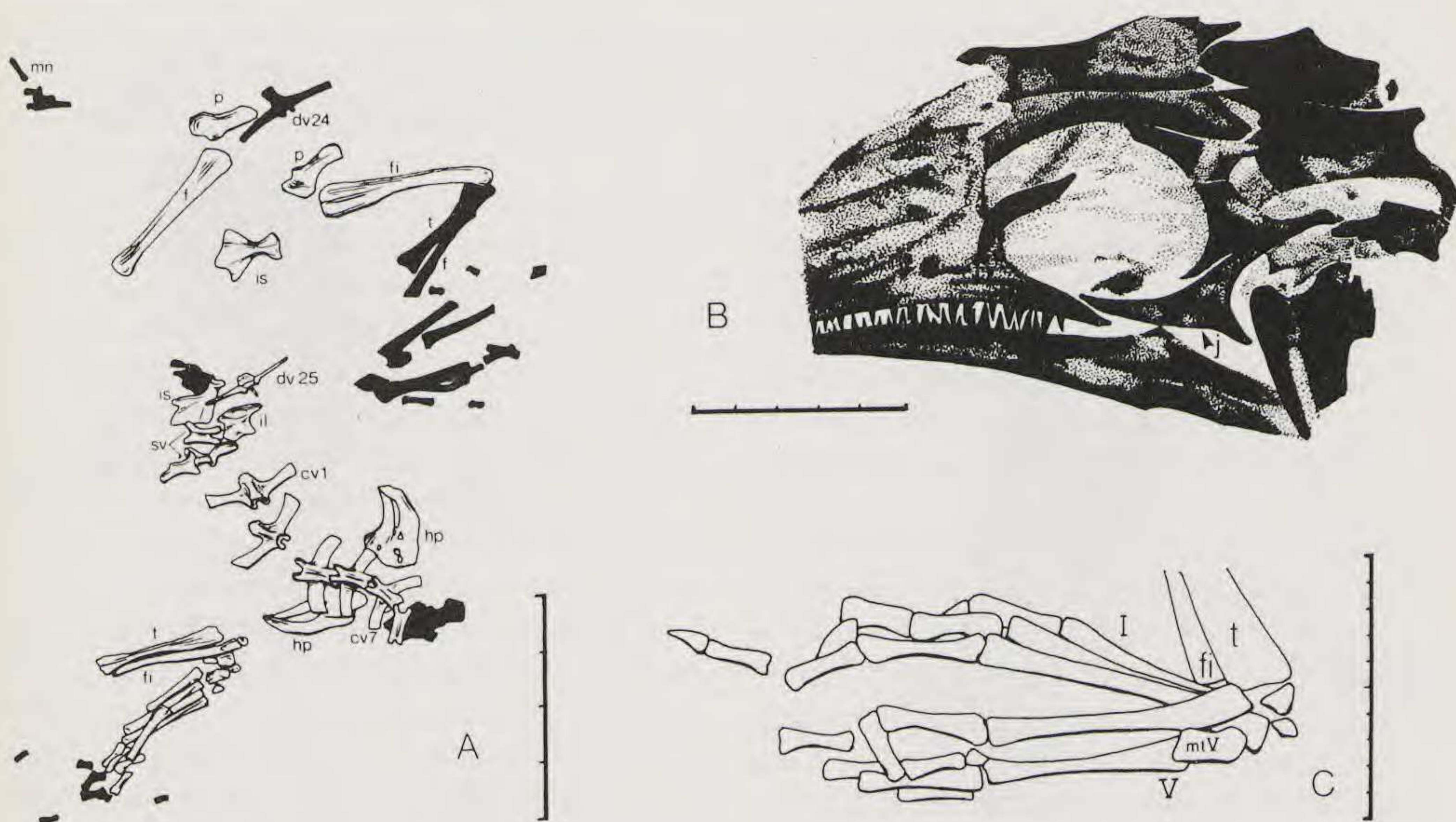
**Diagnosis:** Small, gracile tanystropheid skull as for family, with large orbits. Teeth closely spaced, sharply pointed, with thecodont or subthecodont emplacement. Neck nearly as long as trunk. Vertebrae procoelous with 12 cervicals, 13 dorsals, 2 sacrals, and at least 25 caudals. Cervical vertebrae 3–6 with closely parallel splintlike ribs, the posterior extension of which is about two vertebrae in length. Cervical vertebrae 7–12 with shorter, plowshare-shaped ribs that become larger on posterior vertebrae. Anterior dorsal ribs di-cephalous, posterior dorsal ribs single-headed. Last two or three dorsal vertebrae bear long but slender, slightly anteriorly directed transverse processes, but seemingly no ribs. Anterior caudal vertebrae with long transverse processes that shorten and disappear by the sixth or seventh caudal. Total length of tail about twice that of trunk. Pectoral and pelvic girdle as for family. Forelimbs relatively short: humerus  $0.84 \times$  length of femur, ulna  $0.46 \times$  length of humerus. Hind limbs long: femur  $5.2 \times$  length of single dorsal vertebra, tibia  $0.68 \times$  length of femur. Pes very large with third metatarsal  $0.79 \times$  length of tibia with structure as for family (proportions based on Table 1). Differs from *Tanystropheus* principally in having procoelous vertebrae, shorter cervical vertebrae, plow-shaped posterior cervical ribs, relatively longer hind limb and pes, and a much smaller maximum size.

## Discussion

The fossil record of lepidosaurs is replete with cases of apparent iterative evolution of characters and trends in characters; for

example, Carroll (1977) and Robinson (1975) have shown that a hooked fifth metatarsal, once thought to be of considerable phylogenetic importance (Goodrich, 1916), was probably independently derived four times in different phyletic groups. Likewise, Robinson (1973) and Gow (1975) have demonstrated that the incomplete jugal arch, so characteristic of lizards, evolved (in slightly different ways) in a minimum of two additional, nonlizard lineages. Clearly, differentiating the phylogenetic significance of the characters visible in *Tanytrachelos* is beyond the scope of this preliminary description; it would require the examination of the rest of the reptiles. Due to the nature of the material, furthermore, the characters visible on *Tanytrachelos* are gross morphologic ones, details of bone articular surfaces, braincase morphology, and even skull-bone shape are obscured in the presently prepared material. Therefore, for this work, a cladistic approach (in the sense of Schaeffer, Hecht, and Eldredge, 1972) will be used in which the characters relevant to the relationships of *Tanytrachelos* are listed at each level of comparison in the classificatory hierarchy. The distribution of these characters in the relevant sister groups are documented by Goodrich (1916), Robinson (1973, 1975), Gow (1975), and Carroll (1977).

*Tanytrachelos* can be distinguished from *Tanystropheus*, its presumed nearest relative, by the following uniquely derived characters (with respect to its suborder): procoelous vertebrae, very large plowshare-shaped ribs on the posterior cervical vertebrae (Figs. 2, 4, 5); and long straight ribs fused to the last three posterior dorsal vertebrae and anterior caudal vertebrae (Figs. 2, 3, 4, 5). There are three obvious characters that are shared by *Tanytrachelos* and *Tanystropheus* (and possibly *Cosesaurus*) and no other reptiles known to this author: a short metatarsal with an elongate (metapodiallike) proximal phalanx on digit V (Figs. 3, 4); crescent-shaped heterotopic bones lateral to the proximal caudal vertebrae [in Type A individuals (Figs. 2, 3, 4)]; and a vertebral count of 12 cervicals and 13 dorsals. These are apparently shared, derived characters which unite *Tanystroph-*

**Fig. 3**

*Tanytrachelos ahynis*. A, posterior portion of YPM 7621, Type A; unprepared portions in black—scale 4 cm; B, skull of YPM 7402; note shape of jugal—scale 0.5 cm; C, Pes of YPM 7540; note short, hooked metatarsal V and elongate proximal phalanx of V—scale 1 cm. Abbreviations: cv,

caudal vertebra; dv, dorsal vertebra; f, femur; fi, fibula; hp, heterotopic bones of the Type A ? hemipenes; il, ilium; is, ischium; j, jugal; mn, bones of the left manus; mt V, metatarsal of digit V; p, pubis; sv, sacral vertebrae; t, tibia; I, digit I; V, digit V.

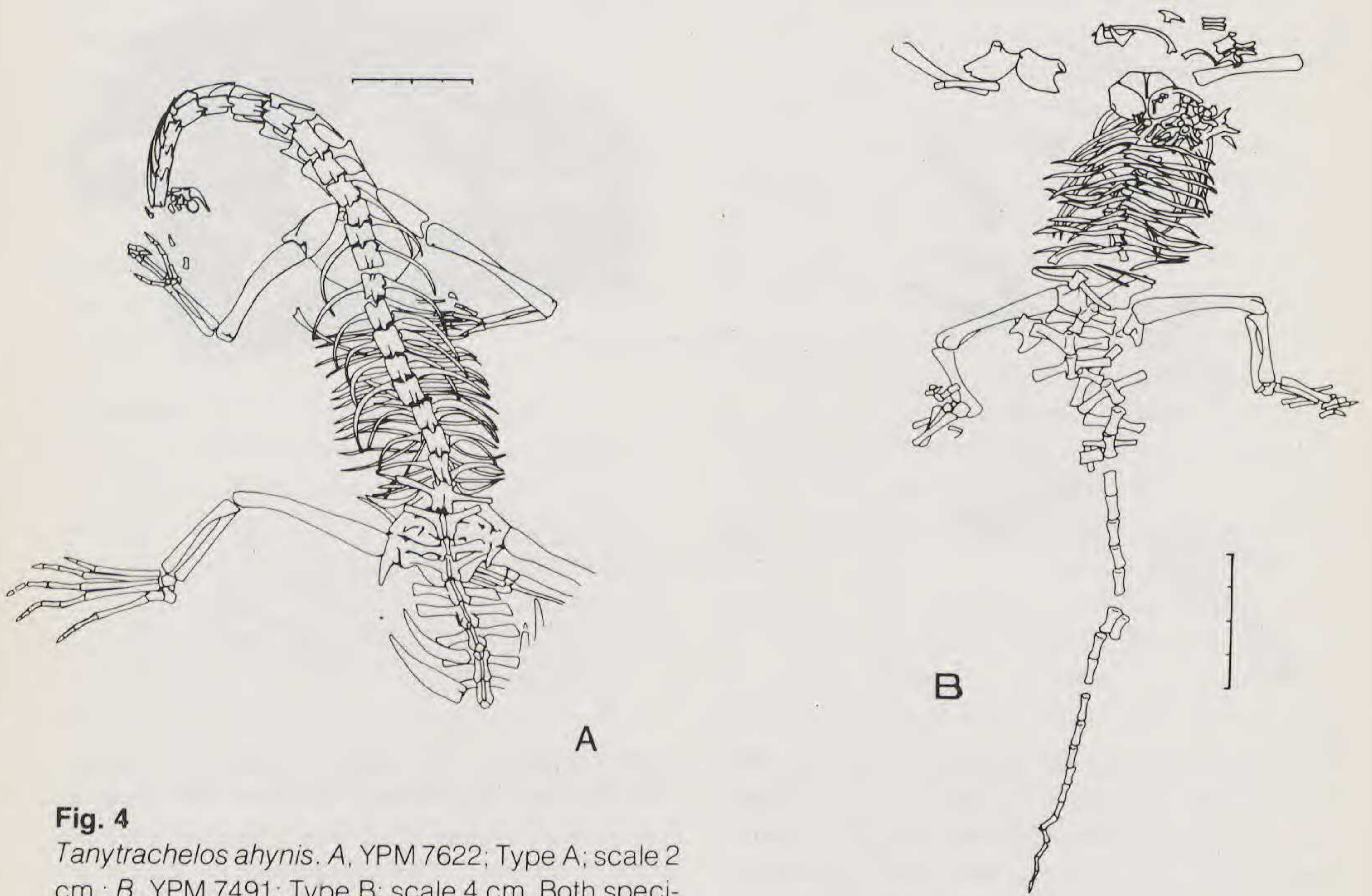
*eus* and *Tanytrachelos* as sister genera in the family Tanystropheidae Gervais, 1895. The families Prolacertidae (*Macrocnemus* and *Prolacerta*) and Tanystropheidae have the same general arrangement of skull bones (Fig. 3), a hooked metatarsal V (Figs. 2 and 4), and an incomplete jugal arch. These shared, derived characters (with respect to other eosuchians) illustrate that these two families are probable sister groups to be included in the suborder Prolacertiformes (Gow, 1975). I feel, however, that the characters that establish the family Tanystropheidae do not justify the formation of the separate and redundant suborder Tanysitrachelia (Peyer, 1931). According to Gow (1975) the Prolacertiformes are related to the basal stock of the archosaurs and presumably would, therefore, belong in the order Eosuchia, as defined by Carroll (1977).

As noted by Carroll (1977) procoelous vertebrae evolved in parallel at least twice in the true lizards. The procoelous condition is also present in *Tanytrachelos* and this character

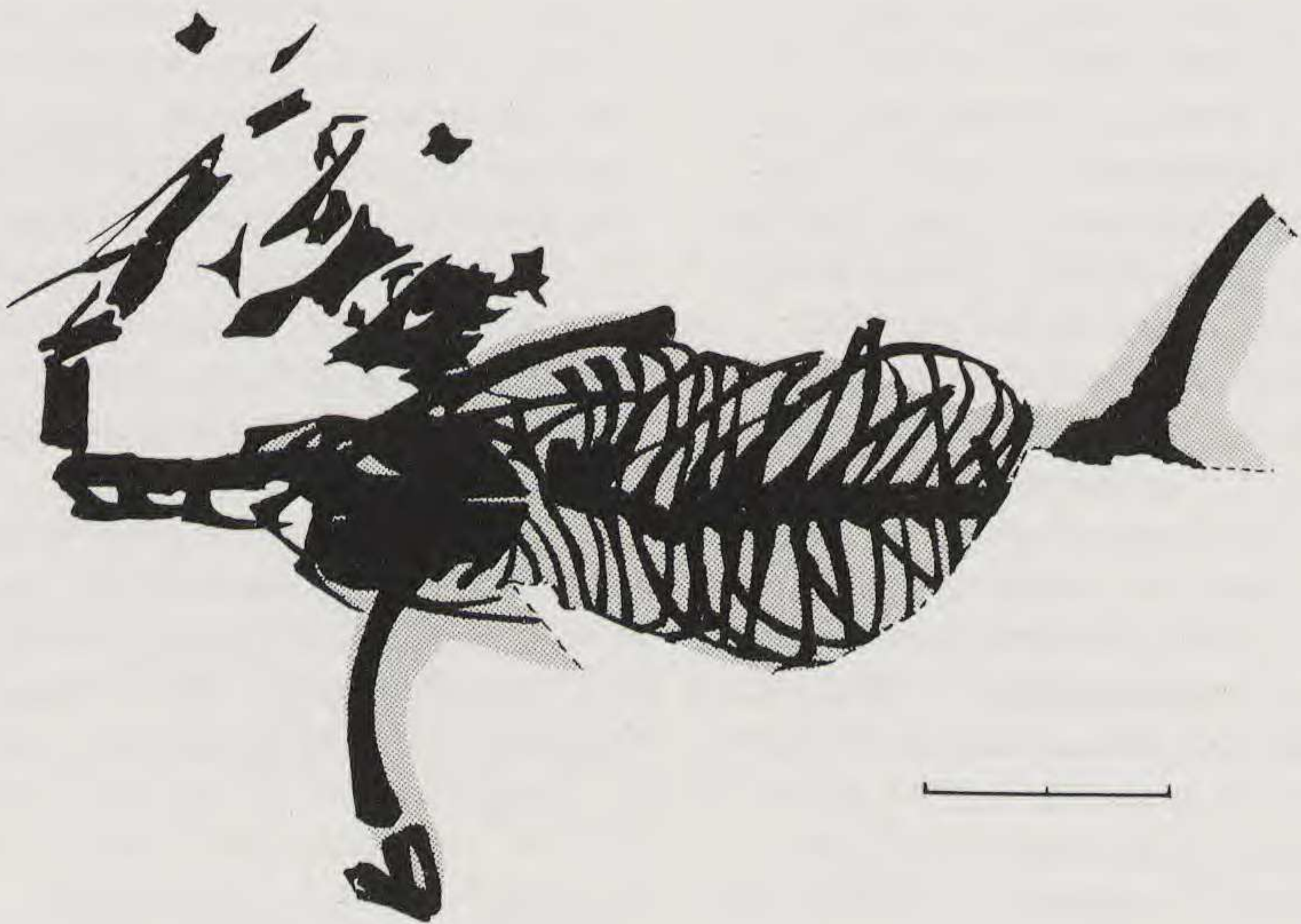
could be cited as evidence of relationship between *Tanytrachelos* and the lizards. I feel, however, that the three derived characters (the unique pes, vertebral count, and heterotopic bones) that *Tanytrachelos* shares with *Tanystropeus* effectively demonstrate that this procoelous condition is a convergent development within the Tanystropheidae. It is yet another example of the complexity of iterative character states in diapsids and their derivatives.

The association of *Tanytrachelos* with numerous fossil fishes, a lacustrine insect assemblage, abundant branchiopods, and phyllocarids (Olsen, et al., 1978) suggests it was aquatic as Wild (1973) believes was the case for *Tanystropeus*. The general proportions and limb morphology of *Tanytrachelos* are consistent with this interpretation.

Some of the specimens of *Tanytrachelos* preserve traces of soft tissue and body outline as a thin, silvery film. YPM 7541 shows this best (Fig. 5) and illustrates that the skin of the limbs is smooth, whereas that of the belly (and



**Fig. 4**  
*Tanytrachelos ahynis*. A, YPM 7622; Type A; scale 2 cm.; B, YPM 7491; Type B; scale 4 cm. Both specimens unprepared.



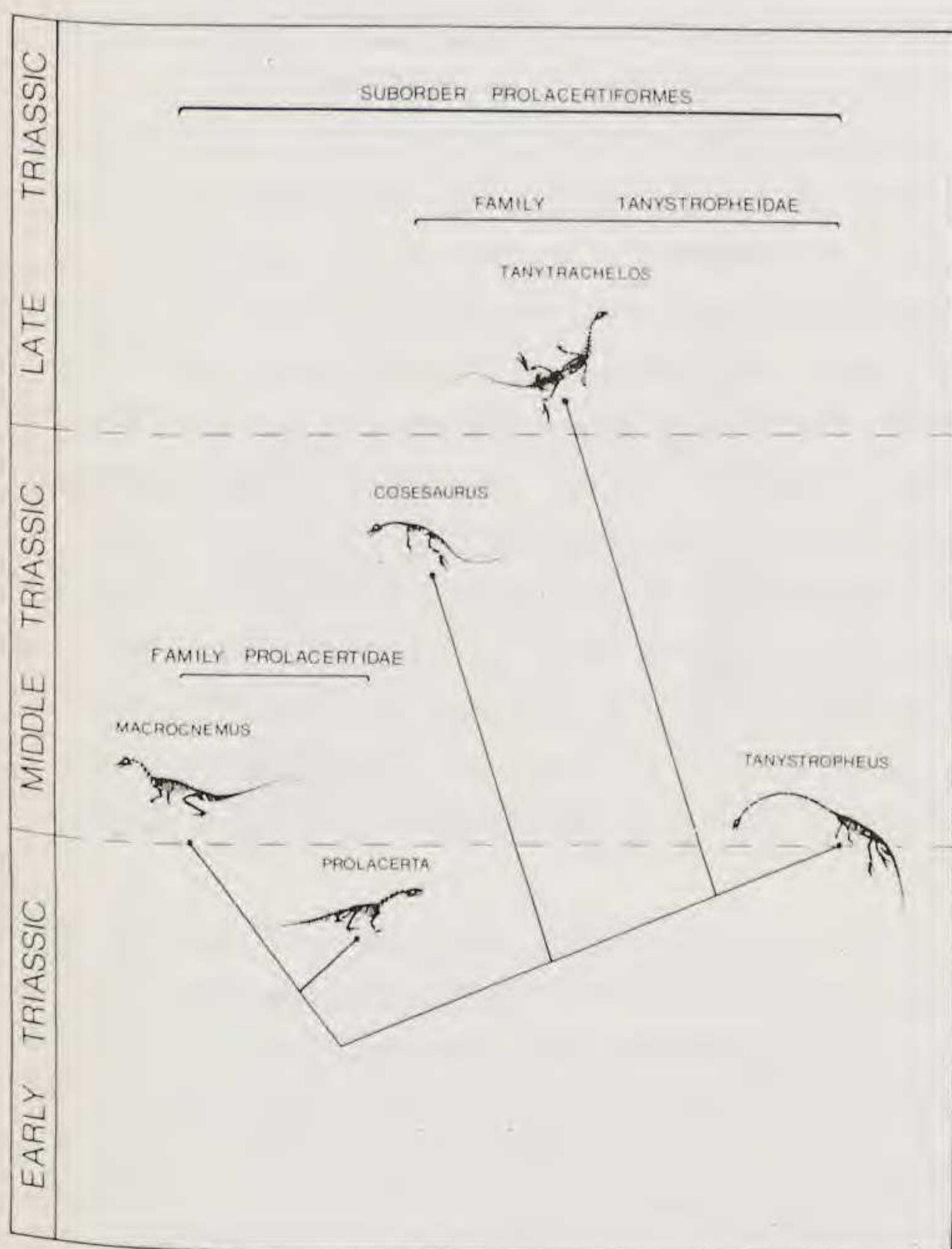
**Fig. 5**  
*Tanytrachelos ahynis*, YPM 7541. Shaded area represents preserved traces of soft tissue. Scale 2 cm.



or back) is granular in texture. No direct evidence of webbing of the pes has been found although it seems likely that the feet were webbed in life.

About half of the specimens in all size classes of *Tanytrachelos* have a pair of anteriorly curved, triangular heterotopic bones lateral to caudal vertebrae 4 through 6 (Figs. 2, 3, 4). Similar structures occur in *Tanystropheus*, and Wild (1975) believes they might be the analogue of the mammalian baculum for the reptilian hemipenes. But since these structures are not found in other reptiles, it may be they served another function, such as support for an egg (embryo?) pouch in the female. Because of this uncertainty, for the purposes of this paper the individuals with these structures will be termed Type A and those without them Type B (see "Hypodigm").

The Lockatong Formation of the Newark Basin (Fig. 6) is lithologically similar to and



**Fig. 6**

Diagram of the hypothetical cladistic relationships within the Prolacertiformes, including *Tanytrachelos* (n.gen.), showing the earliest known occurrences (dots at ends of lines).

approximately contemporaneous with the Cow Branch Formation (Olsen, et al., 1978). The Lockatong has produced an exceptionally diverse variety of small reptiles, and these were examined to determine their relationship, if any, to *Tanytrachelos*. *Icarosaurus*, from the lower Lockatong of North Bergen, New Jersey, is a kuehneosaurid lizard with marked adaptations for flight and is so different from *Tanytrachelos* that no further consideration need be given it. *Rhabdopelix* (Cope, 1870) is a composite of several individuals (if not several taxa) of small reptiles, some of which may be related to *Icarosaurus* (Colbert, 1966). *Gwynnedosaurus* (Bock, 1945) is from the same locality as *Rhabdopelix*. A redescription of *Gwynnedosaurus* will be given elsewhere; however, it should be noted that some of the bones of *Rhabdopelix* figured by Cope (1870) are nearly identical to portions of *Gwynnedosaurus*. The latter has a partially emarginate scapulocoracoid and could be a true lizard. These two genera, then, are not closely allied to *Tanytrachelos*. Colbert (1966) mentions several undescribed small reptiles from the same locality as *Icarosaurus*. One of these, AMNH 1721, has amphicoelous dorsal vertebrae (Colbert, 1966), and of the 13 vertebrae visible, at least 9 have very long transverse processes (or fused ribs) and unique-appearing gastralia; so it is not relevant. Another, AMNH 7206, consists of a small disarticulated skeleton in association with a large amount of scattered *Diplurus newarki* (coelacanth) material. The bones present are of a generalized lepidosaurian nature, and no diagnostic elements are obvious; it cannot be completely ruled out that this reptile might be *Tanytrachelos*. Finally, AMNH 7282 is a small, very fragmentary reptile with only proximal caudal vertebrae and some elongate hemal arches preserved. The caudal vertebrae bear high, anteriorly directed neural spines and very short transverse processes. This, too, cannot be *Tanytrachelos*. Thus, despite the presence of at least five taxa of small reptiles in the Lockatong, positive evidence for the presence of *Tanytrachelos* is lacking. In marked contrast, the fish faunas of the Lockatong and Cow Branch Formations are nearly identical (Olsen, et al., 1978).

A possible *Tanytrachelos* relative is *Cosesaurus* (Ellenberger and de Villalta, (1974) from the upper Muschelkalk of Spain. It has very gracile proportions, a pointed snout, and large orbits. Ellenberger and de Villalta believe *Cosesaurus* to be a "proto-bird." From what can be seen of the pes, vertebral count, and pectoral girdle in the published photographs, it is more likely to be a primitive member of the Tanystropheidae as defined here. It differs from *Tanytrachelos* in the less specialized nature of the cervical ribs, shorter transverse processes on the anterior caudal vertebrae, and a somewhat proportionally longer tibia and fibula. The pes (again from the photographs) seems to have the short metatarsal V and the elongate proximal phalanx typical of tanystropheids.

#### Distribution of the Tanystropheidae

As defined above, the family Tanystropheidae comprises at least *Tanystropheus* and *Tanytrachelos*. *Tanystropheus* is known from the upper Buntsandstein (Middle Triassic, Anisian) of Germany (Ortlam, 1967), the Muschelkalk of Central Europe, the Grenzbitumenzone (Anisian-Ladinian) of Southern Europe, and the Middle Triassic of Israel. Recently, Donald Baird (personal communication) identified *Tanystropheus* sp. (Princeton University Number 22000) in a small assemblage of reptiles and amphibians from the lower Wolfville Formation (Fundy Group of Newark Supergroup) of Lower Economy, Nova Scotia, Canada. Other elements of the fauna suggest an Early to Middle Triassic age for this locality. In contrast, *Tanytrachelos* is, of course, known only from the one Late Triassic locality in the southeastern United States described here. *Cosesaurus*—a possible tanystropheid—comes from the Spanish Middle Triassic. One more tanystropheid may be the specimen mentioned by Cruickshank (1972) from the Yerrapalli Formation (Middle Triassic—Kutty, 1969). If this is a tanystropheid, it represents the only Gondwana example of the family. Thus, the distribution of the Tanystropheidae may be cosmopolitan

and members lived from early Middle Triassic through early Late Triassic.

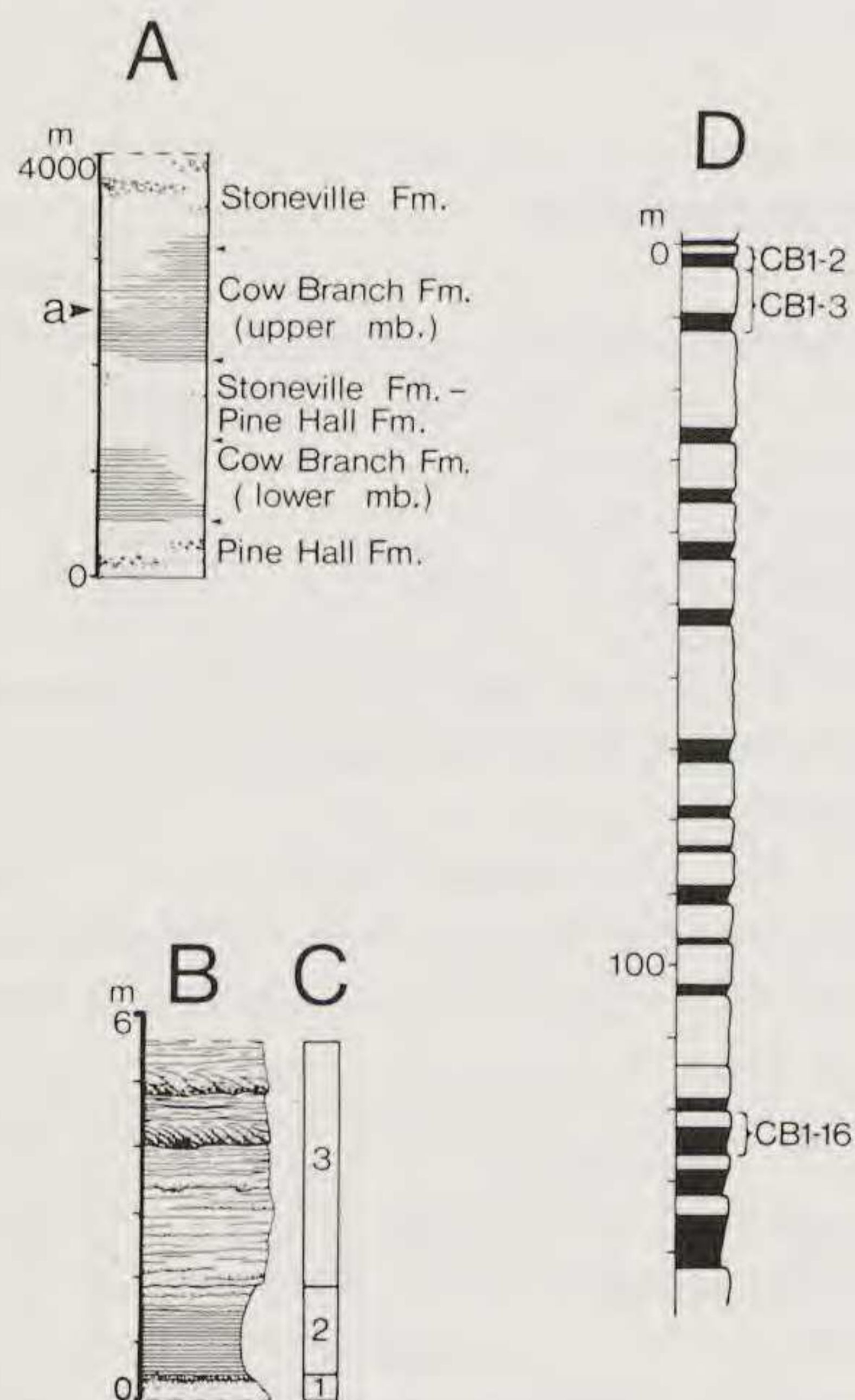
#### Geology of the *Tanytrachelos* Locality

The Early Mesozoic Newark Supergroup (Olsen, 1978) consists of thick sections of nonmarine red, gray, and black sedimentary rocks and associated volcanics preserved in a number of elongate tectonic basins which are aligned with the regional trend of the Appalachian Mountains. Thirteen major basins containing Newark Supergroup rocks are exposed in the Piedmont Province of eastern North America; others are known to exist beneath Atlantic Coastal Plain sediments and on the Continental Shelf (Olsen, in press; Jansa and Wade, 1975). The Dan River Group (Fig. 7) of the Newark Supergroup is exposed in central North Carolina and Virginia in the contiguous Danville and Dan River Basins. Thayer (1970) has divided the Dan River Group into three interdigitating formations: the Cow Branch Formation, consisting of several large lenses of black and gray siltstone and sandstone; the Pine Hall Formation, composed of pink and buff sandstone, red, buff, and gray siltstone, and buff conglomerate; and the Stoneville Formation, made up of red and gray siltstone, sandstone, and conglomerate. Near Eden, North Carolina, 560 m of Pine Hall Formation rests on the Pre-Newark metamorphic rocks, and is overlain by 600 m of the lower member of the Cow Branch Formation. This is succeeded by a 740 m tongue of Pine Hall Formation which is overlain by 710 m of the upper member of the Cow Branch Formation. Finally, 1130 m of Stoneville Formation overlie this.

To the north of Eden, the upper member of the Cow Branch Formation thickens considerably and consists of repetitive, coarsening-upwards cycles (Thayer, Kirstein, and Ingram, 1970) similar to those in the Lockatong Formation of the Novacaesarea Group (Newark Supergroup of the Newark Basin). The modal cycle (one which best represents the observed section—Duff, Hallam, and Walton, 1967) is composed of three divisions (Fig. 8): 1) a basal platy, dark

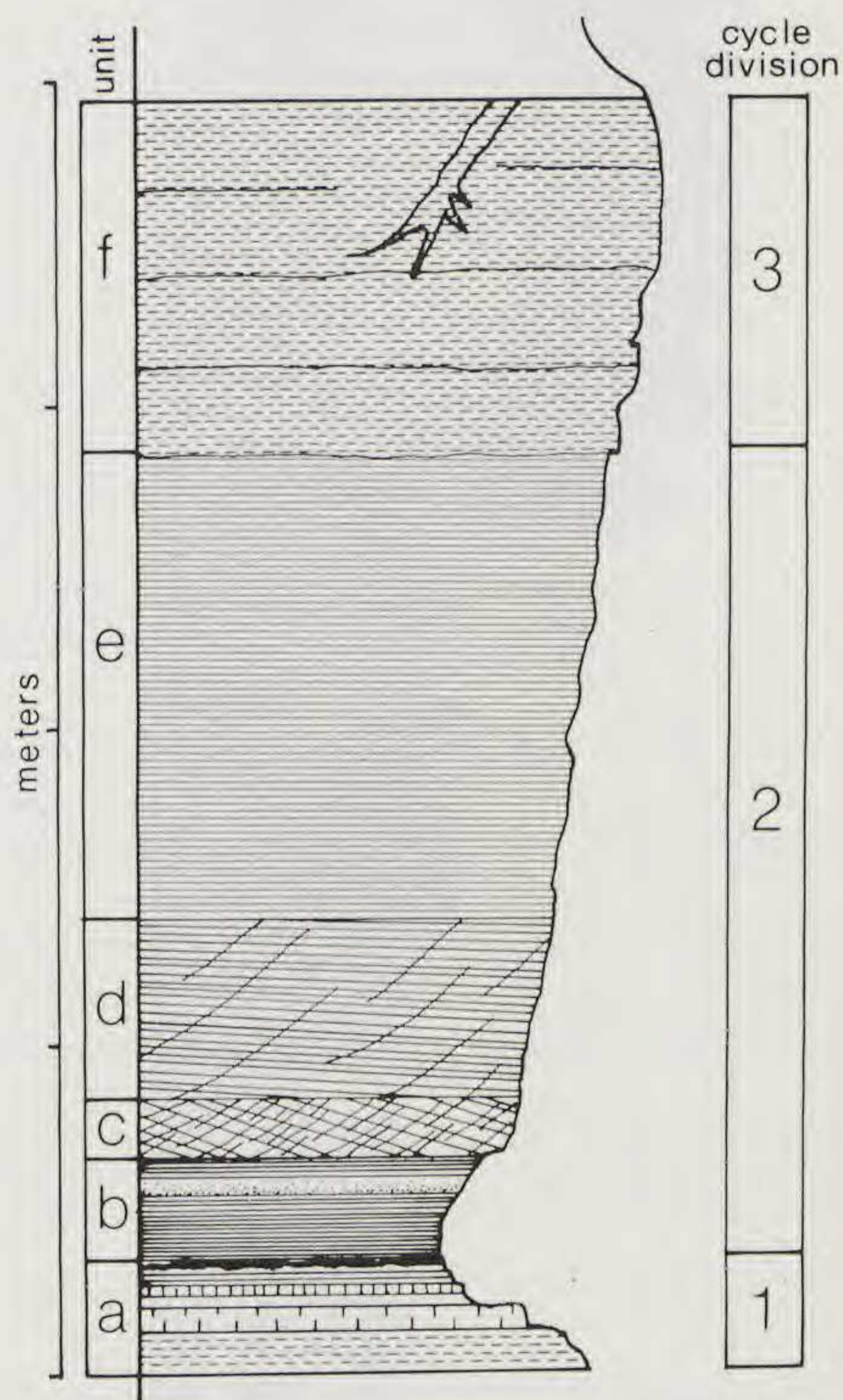
gray, often calcareous siltstone; 2) a middle finely laminated calcareous siltstone (laminite); and 3) an upper massive siltstone and sandstone. The source of most of the material of *Tanytrachelos* is Division 2 of a single cycle about 540 m above the base of the upper member of the Cow Branch Formation (CB1-2). This is exposed for about 135 m along strike as part of a single continuous section in which 17 other cycles are exposed (Figs. 7, 8, 9). Two partial *Tanytrachelos* specimens have been found in unit CB1-3 near locality CB1-2-E (Fig. 9), and it seems likely that most of the material from rubble in CB1-A is from this unit. In addition, a small fragment

which could be *Tanytrachelos* (YPM 8075) has been found in cycle CB1-16. Unfortunately, the specimen is too fragmentary for positive identification. It is clear, however, that the distribution of specimens of *Tanytrachelos* through several cycles shows that its density is not an isolated fluke of preservation but, rather, is characteristic of the facies.



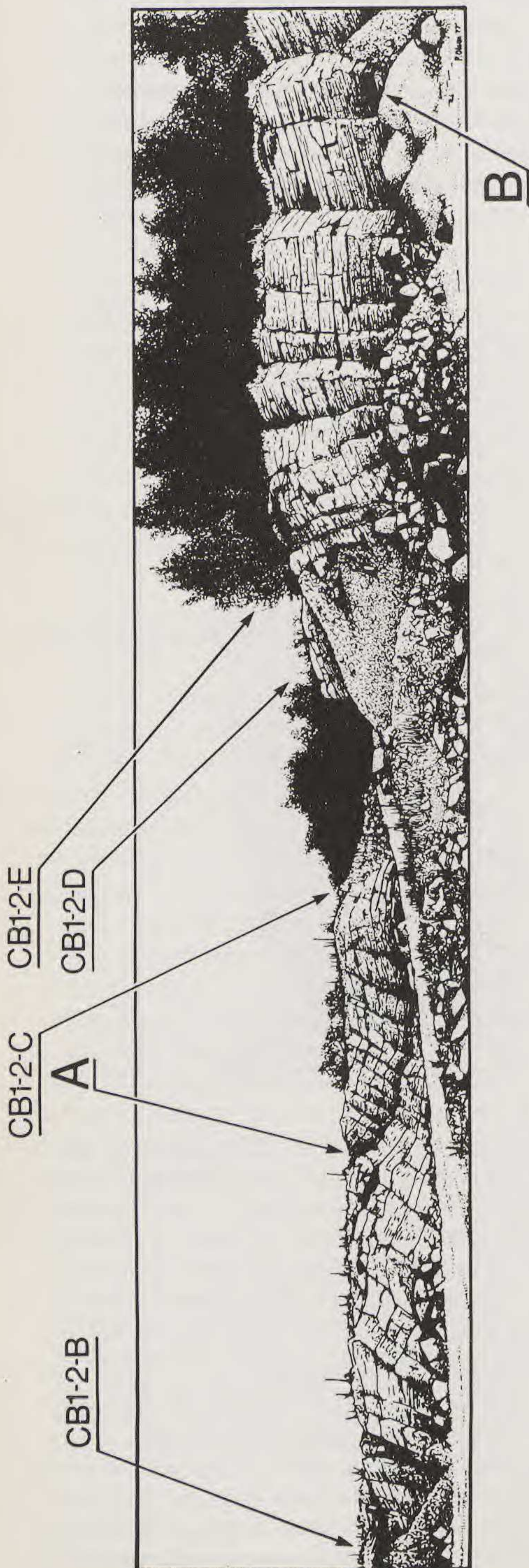
**Fig. 7**

A, Idealized section through the Dan River Group near Eden, North Carolina; approximate position of the *Tanytrachelos* locality at *a*. B, Modal cycle for the upper Member of the Cow Branch Formation. C, Divisions of the modal cycle. D, Stratigraphic section at the *Tanytrachelos* locality showing position of reptile-bearing horizons (CB1-2, CB1-3, CB1-16). Division 2 of each cycle shown in black; cycles numbered from top down, contrary to normal practice, because of the uncertain number of cycles near the base of the section.



**Fig. 8**

Stratigraphic section at CB1-2-D. *a*, Black and dark gray micaceous siltstone and calcareous fine siltstone, showing some graded bedding and common conifer fragments. *b*, Black, microlaminated, calcareous siltstone containing *Tanytrachelos* material along with well-preserved insects and crustaceans, numerous fossil fish and plants, and also a graded coarse siltstone bed near top of unit. *c*, Black siltstone, intensely slickensided and disturbed. *d*, Black pyritic, well-bedded siltstone with common slickensided bedding planes. *e*, Microlaminated siltstone with numerous crumpled casts of a salt and with conifer stems. *f*, Gray, well-bedded siltstone with scour marks on bedding planes and large plant stems in growth position.



Transgressions and regressions of a large lake in a slowly subsiding depositional basin could have resulted in the Cow Branch cycles (Olsen, et al., 1978). In particular, the *Tanytrachelos* layers (Division 2 of cycles CB1-2, CB1-3, and CB1-16) were probably deposited in the anoxic waters beneath the chemocline of a perennially stratified lake during its maximum transgression. Existing faunal and floral data (Olsen, et al., 1978 and Olsen, MS, 1978b) suggest that the upper member of the Cow Branch Formation correlates with the Lockatong Formation of the Newark Basin (lower part of Zone 1 of Olsen and Galton, 1977) and that these correlate with the German middle Middle Keuper (Late Carnian).

#### Acknowledgments

The scientific community is indebted to the owners of the *Tanytrachelos* locality for permission to collect specimens and carry out excavations on their property. Indeed, throughout the field work, they assisted in numerous ways, and it is largely due to their generosity that *Tanytrachelos* has been discovered.

I thank Drs. Donald Baird, W. Bruce Cornet, Jr., Jean-Claude Gall, John H. Ostrom, John Rodgers, Hans-Dieter Sues, Keith S. Thomson, and Karl M. Waage for many hours of discussion about the fauna, flora, and geology of CB1. Dr. Edwin H. Colbert kindly provided photographs of two of the undescribed North Bergen reptiles (Lockatong Formation). Dr. Eugene S. Gaffney gave access to the third, and Dr. Earl Shapiro of the Academy of Natural Sciences of Philadelphia loaned *Gwynnedosaurus*. The manuscript was read by Dr. Baird, Amy J. Litt, Dr. Ostrom, and Kevin Padian.

#### Fig. 9

The *Tanytrachelos* locality showing the positions of localities CB1-2-B through CB1-2-E and the positions of the reptile-bearing portions of cycles CB1-2 (A) and CB1-3 (B). Distance from CB1-2-B to CB1-2-E is about 135 m. Note the flaggy nature of the beds. View is to the west.

Stan P. Rachootin, and Dr. Thomson. Introduction to the owners was through Dr. Paul H. Knappenberger, Jr. of the Virginia Museum of Science. Special thanks must go to Robert F. Salvia and Robert Brombaugh who worked with me during the field work, often under extremely difficult conditions.

Work was made possible by a grant from the National Science Foundation to Dr. Thomson (BMS 74-07759) and grants from the Peabody Museum.

### Note Added While In Press

Additional examination of AMNH 7206 demonstrates the presence of the type of procoelous vertebrae and cervical ribs characteristic of *Tanytrachelos*. In addition, extremely well-preserved specimens of *Tanytrachelos* have been discovered in the lower Lockatong Formation of the Newark Basin at Weehawken, New Jersey. This points up the similarity between the the Cow Branch and Lockatong faunas and their sedimentary cycles (Olsen et al. 1978).

### Literature Cited

- Bock, W.** 1945. A new small reptile from the Triassic of Pennsylvania. *Not. Nat. Acad. Nat. Sci. Philadelphia* 154: 1-8.
- Carroll, R. L.** 1977. The origin of lizards. In S. M. Andrews, R. S. Miles, and A. D. Walker [eds.] *Problems of Vertebrate Evolution*, Linn. Soc. Symp. Ser. 4: 359-396.
- Colbert, E. H.** 1966. A gliding reptile from the Triassic of New Jersey. *Amer. Mus. Novitates*, 2230: 17-32.
- Cope, E. D.** 1870. Synopsis of the Extinct Batrachia and Reptilia of North America, Part II. McCalla and Stavely, Philadelphia, 105-235.
- Cruickshank, A. R. I.** 1972. The proterosuchian thecodonts. In K. A. Joysey and T. S. Kemp [eds.] *Studies in Vertebrate Evolution*, p. 89-119. Winchester Press, New York.
- Duff, P. McL.D., A. Hallam, and E. K. Walton,** 1967. Cyclic sedimentation. *Developments in Sedimentology*, Vol. 10, 280 p. Elsevier, Amsterdam.
- Ellenberger, P. and J. F. de Villalta.** 1974. Sur la présence d'un ancêtre probable des Oiseaux dans le Muschelkalk supérieur de Catalogne (Espagne). Note préliminaire. *Acta Geol. Hispanica* 9: 162-168.
- Gervais, P.** 1858. Description de l'*Aphelosaurus latevensis*, saurien fossile des schistes Permien de Lodève. *Am. Sci. Nat.* 10: 233-235.
- Goodrich, E. S.** 1916. On the classification of the Reptilia. *Proc. R. Soc. London, Ser. B*, 89: 261-276.
- Gould, S. J.** 1977. *Ontogeny and Phylogeny*. Belknap Press (Harvard Univ. Press) Cambridge, Mass. 501 p.
- Gow, C. E.** 1975. The morphology and relationships of *Youngina capensis* Broom and *Prolacerta broomi* Parrington. *Palaeont. Afr.* 18: 89-131.
- Jansa, L. F. and J. A. Wade.** 1975. Geology of the continental margin off Nova Scotia and Newfoundland. In W. J. M. Van der Linden and J. A. Wade [eds.] Vol. 2, *Offshore Geology of Eastern Canada*. Geol. Surv. Can. Pap. No. 74-30: 51-105.
- Kutty, T. S.** 1969. Some contributions to the stratigraphy of the upper Gondwana formations of the Pranhita-Godavari Valley, Central India. *J. Geol. Soc. India* 10: 33-48.
- Olsen, P. E.** 1978. On the use of the term Newark for Triassic and Early Jurassic rocks of eastern North America. *Newsl. Strat.* 7:90-95.
- Olsen, P. E. and P. M. Galton.** 1977. Triassic-Jurassic tetrapod extinctions: are they real? *Science* 197: 983-986.
- Olsen, P. E., C. L. Remington, W. B. Cornet, Jr., and K. S. Thomson.** 1978. Cyclic change in late Triassic lacustrine communities. *Science* 201: 729-733.
- Ortlam, D. von** 1967. Fossile Böden als Leithorizonte für die Gliederung des Höheren Bundsandsteins in nördlichen Schwarzwald und südlichen Odenwald. *Geol. Jahrb.* 84: 485-590.
- Peyer, B.** 1931. *Tanytropheus longobardicus* Bass. sp.: Die Triasfauna der Tessiner Kalkalpen II. *Abh. Schweiz. Palaeont. Ges.* 50: 5-110.
- Robinson, P. L.** 1973. A problematic reptile from the British Upper Triassic. *J. Geol. Soc.* 129: 457-479.
- 1975. The functions of the hooked fifth metatarsal in lepidosaurian reptiles. *Colloq. Int. C. N. R. S.*, p. 461-483.

- 
- Schaeffer, B., M. K. Hecht, and N. Eldredge.** 1972. Phylogeny and Paleontology. *Evol. Biol.* 6: 31–46.
- Thayer, P. A.** 1970. Stratigraphy and geology of Dan River Triassic Basin, North Carolina. *Southeast. Geol.* 12: 1–31.
- Thayer, P. A., D. S. Kirstein, and R. L. Ingram.** 1970. Stratigraphy, Sedimentology and Economic Geology of Dan River Basin, North Carolina. Guidebook, Carolina Geological Society, Raleigh, North Carolina, 44 p.
- Van Houten, F. B.** 1977. Triassic-Liassic deposits of Morocco and eastern North America: comparison. *Bull. Amer. Assoc. Petr. Geol.* 61: 79–99.
- Wild, R.** 1973. *Tanystropheus longobardicus* (Bassani) (Neue Ergebnisse); Die Triasfauna der Tessiner Kalkalpen XXIV. *Abh. Schweiz. Palaeont. Ges.* 95: 1–162.

#### Unpublished References

- Olsen, P. E.** 1978a. Fossil localities in the Newark Supergroup: 1970–1978. Unpublished report, Peabody Mus. Nat. Hist. Archives, Yale Univ.
- 1978b. Stratigraphy and nomenclature of the Newark Supergroup of New Jersey and adjacent Pennsylvania and New York. Unpublished MS.

---

#### The Author

**Paul Eric Olsen.** Department of Biology,  
Yale University, New Haven, Connecticut  
06520.